Experiment in Entrepreneurship
Building up an Excellence Center for Oil & Gas Engineering Education
PETROBRÁS, EFEI/GEFEI and UFRJ/COPPE

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Abstract- *Petrobrás was set up under Law 2004 dated 3 October 1953, which introduced Brazil's Oil Monopoly and stipulated that a state-owned company would implement it.*

At that time, Brazil's refining output was under 40,000 barrels per day (bpd). Refining activities carried out by the recently-incorporated state-owned company totaled some 2,500 bpd, while national demand for oil products topped 137,000 bpd, and the nation's oil reserves barely reached 15 million barrels. Limited to a small area in Bahia State, exploration and production activities totaled 2,500 bpd.

The mission of this state-owned company was defined as follows:

1. *Guaranteeing the nation's oil product supplies;*
2. *Developing oil and gas exploration and production activities throughout the country;*
3. *Handling the refining and transportation of oil, gas and related products.*

To carry out these tasks - which naturally included setting up a refining park in Brazil, as well as developing its own oil and gas exploration and production technologies – Petrobrás focused on intensive training of a skilled labor force and an ample interchange with Brazilian universities in all areas of Science and Technology as well as in other fields of knowledge. This was spurred by the limited access to oil technology available when Petrobrás was first established. Right from the start, the Company also focused on outsourcing, ensuring that Brazil developed a massive support framework for the nation's infant oil industry, ranging from engineering through maintenance to assembly. In parallel, Brazil's capital goods sector benefited greatly from the activities of its domestic oil industry.

This work covers the development of an experimental coalition linking the strategic Centers of Excellence Model for Petrobrás/Coppe (UFRJ) and the methodology of the Itajubá Engineering College - EFEI for training engineering students in entrepreneurial skills. This experiment is intended to launch Petrobrás on the path to making good use engineers with a new profile shaped by innovative academic education methods focused on the entrepreneurial spirit and intensive use of information technology resources.

Centers of Excellence – Model

As conceptualized by Petrobrás, the Centers of Excellence Project is based on a network that incorporates knowledge, know-how, resources, facilities, installations and marketing, and is also linked to Federal Science and Technology Projects.

One or more Anchor Universities are appointed for each project, with the role of completing, supplementing or supplying the necessary research, while setting up undergraduate or graduate courses linked to specific topics. These developments are then transferred to other Universities, which in turn set up their own research networks. This integration may be physical, such as laboratories common to both the Universities and Petrobrás, or can be handled through clearly-defined projects. This approach ensured that Brazilian Universities were involved in this Centers of Excellence Project right from the very beginning.

There are also links with private or state-owned companies focused on the development of new products, processes, equipment and software, as well as for joint actions on the market. The Petrobrás name - and its applications throughout the nation's oil industry - underwrites the expansion of actions on the global market. After implementation focused on specific themes suggested by Petrobras, this Project currently has applications running at private companies and institutions all over the country, making it a truly Brazilian Project.

The Centers of Excellence Project (PECE) is based on five assumptions:

1. Every company is a technology application laboratory;
2. The use of cooperative in-house and/or external research networks, together with the skills of Universities supporting firms and aid from abroad through foreign research institutes and companies, can upgrade the capabilities of any company in any area;
3. Technological growth is a vital factor in competitiveness, and technology can be marketed either through normal products, or in isolation;
4. Industrial applications of technology bring ample returns over the short term, boosting profits;
5. The core companies in this Project are the mainstay of the Centers of Excellence Project and preferential customers for its actions. Clustering technological

reserves allows activities to spread beyond corporate borders.

The Centers of Excellence Project represents a partnership model with broad-ranging contours. These partnerships involve Petrobrás, the Brazilian Government and universities, as well as local companies and institutions, all backed by strong links with the rest of the world at the *Market, Strategic and Technological* levels. The issues offer interesting opportunities for strategic coalitions in areas such as Deepwater Operations, Naval and Offshore Technology, Distance Education, Asphalt Paving, Business Management and many others. This integration could well enhance the capacity of participant institutions, fostering the insertion of Brazil into the globalized market complex on a solid basis, and integrating various national technological, industrial, economic and social development projects, thus making the best possible use of the resources available.

The basic concept of each Center of Excellence turns it into a set of physical, human and technological resources integrated into a theme area network striving to maintain its supremacy in the selected field, while stressing the ongoing sustained development of links and the transformation of technology and knowledge into product. The view of the Project is that each Center of Excellence should do its utmost to be acknowledged as a group of resources at the excellence level, always located on the cutting edge of technology or knowledge within its area. The mission of each Center of Excellence is to seek results on the threshold of the borders of knowledge in any specific industrial, technological or management area, or any other field of specific interest, through the use of innovative techniques and sophisticated scientific methods, grouping highly qualified professionals. Its shape is a **Union** based on a high-performance network perceived as a single unit, extended through **Partnerships** with industries, organizations, universities and federal, state or municipal governments.

The Centers of Excellence Project has already completed various important stages in its maturation process: (1) basic conceptualization; (2) academic theorization; (3) prototype - geochemistry; (4) management and organization modeling; (5) mobilization of themes and groups. This Project was distinguished by the Federal Government at a ceremony held on 23 January 1997 at the *Planalto* Presidential Palace in Brasilia, when a number of significant expansions were approved and defined by the President of Brazil and the Ministers of Science and Technology, the Environment, Education and Culture. Some 22 promising themes are currently being prepared or implemented by groups of Petrobrás departments, with a further twenty themes being launched, headed by Ufrj/Coppe, involving universities, companies and other institutions.

Petrobrás Experience: Center-South & Center-North

The Training and Development (T&D) policy of PETROBRÁS has always been closely linked to the academic community, particularly through agreements with universities and other institutions designed to handle demands from the oil industry for trained professionals, in both qualitative and quantitative terms. This policy has been adapted periodically, with the introduction, replacement and updating of training programs as required, keeping pace with the technological progress of the oil industry and new facilities offered by educational networks in Brazil and abroad.

In fact, training human resources in oil-based activities in Brazil dates back to before the incorporation of PETROBRÁS. An important date is 1952, when the National Oil Council introduced the first course focused specifically on the oil industry: an oil refining course tailored to the priorities of the period. Intended to train process engineers, this course was given by the University of Brazil, designed to train a specialized local work-force that was still non-existent at that time.

When PETROBRÁS was incorporated in 1954, professional training and advanced qualifications were transferred to this new state-owned enterprise, leading to the resizing and expansion of its bases, including research facilities, through the establishment of the Oil Research and Advanced Training Center (CENAP). The principal purpose of this Center was to train specialists and undertake research projects, playing an important role in training mid-level professionals in the operations and operational support areas. From 1956 onwards, PETROBRÁS began to encourage professional training for oil geologists, drilling and production engineers, and equipment maintenance experts.

During the 1960s, the drive to absorb new technologies resulted in more intensive professional training, giving rise to advanced and specialty programs. In 1966, when CENAP was closed down, the Personnel Service (SEPES) and the Petrobrás R&D Center (CENPES) were established to handled the Human Resources and R&D Areas respectively. The Personnel Center began to work with Training and Development through its Teaching Division, consisting of the Rio de Janeiro and Bahia Teaching Sectors (SEN-RIO and SEN-BA).

The period centered on adapting new technologies to local conditions during the 1970s demanded still higher levels of specialization. In 1976, PETROBRÁS ventured into the Distance Education Field for the first time through its *Accesso* Project, providing basic primary and secondary schooling for its staff. During the 1980s PETROBRÁS began to develop state-of-the-art technology in various areas, boosting demands for training slanted towards innovation and sophisticated specialization. During this

period the Supervisors Development Project that offered ongoing education to employees involved in supervisory functions was transformed into yet another PETROBRÁS experiment in Distance Education.

In 1992, the Human Resources Service (SEREC) was set up. The SEN-RIO and SEN-BA sectors made way for the Human Resources Development Center/Southeast (CEN-SUD) and the Human Resources Development Center/North-Northeast (CEN-NOR) respectively. These Centers offer training courses for newly-hired employees of the company, as well as designing and implementing Training and Development Programs that ensure ongoing professional growth while meeting corporate requirements. Consolidating a series of movements that began in the late 1980s, the Educational Technology Segment (STE) was introduced at CEN-SUD in 1993. This provided support for the implementation of Distance Education Projects, while also preparing audio-visual resources and print-outs for educational use. In 1995, the first Computer-Based Training Courses were produced.

The current stage of technological development for Distance Training both in Brazil and worldwide spotlights the need for a wide variety of studies and surveys. The quest and maintenance of excellence forces PETROBRÁS to meet these demands through investments in-house, in parallel to support for outside projects. Eight Distance Education Pilot Projects are currently underway at PETROBRÁS:

- · Master's Degree in Videoconferencing Logistics;
- · Computer-Based Training for Single Materials System;
- · Multi-Media Management Training Program;
- · Environment - Management and Techniques;
- · Foreign Language Program;
- · Industrial Safety;
- · Oil Geopolitics;
- · Industrial Painting.

EFEI Model in Entrepreneurial Training (Entrepreneur Training Project - GEFEI Center)

An innovative experiment is being undertaken by the Itajubá Federal Engineering College (EFEI) is called the Itajubá Entrepreneurship / Enterprise Training and Business Management Center - GEFEI, focused mainly on engineering training with the profile demanded by the market. In addition to rapidly-changing technical know-how, its teaching processes offer the chance to develop the skills and competencies forecast as crucial for the professions of the future.

This Center is essentially based on Entrepreneurship / Enterprise Education as a teaching methodology, fostering the development of the characteristics inherent in entrepreneurs.

The Brazilian version of this new educational trend blends **Entrepreneurship Education** and **Enterprise Education** into a seamless whole tailored to local needs. While Entrepreneurship Education programs often stress technical skills and knowledge focused on profit, Enterprise Education programs are slanted more toward developing individual skills, not necessarily for business purposes. Brazil's newly-coined *Educação Empreendedora* makes the best of both worlds.

In order to act as entrepreneur in the business area (LENKO 1995) states that it is necessary to develop three sets of qualities:

a) Attitudes and Values, such as opportunity for recognition, self-confidence, and challenging conventional wisdom;
b) Human relationship skills, communication, critical, creative thinking, decision-taking, problem-solving, as well as management and organizational skills;
c) Knowledge of economic principles, the business world, marketing, production, finance, legal aspects, and the deployment of technological progress (page 19).

With these sets of qualities, this author presents the following scheme (Figure 1):

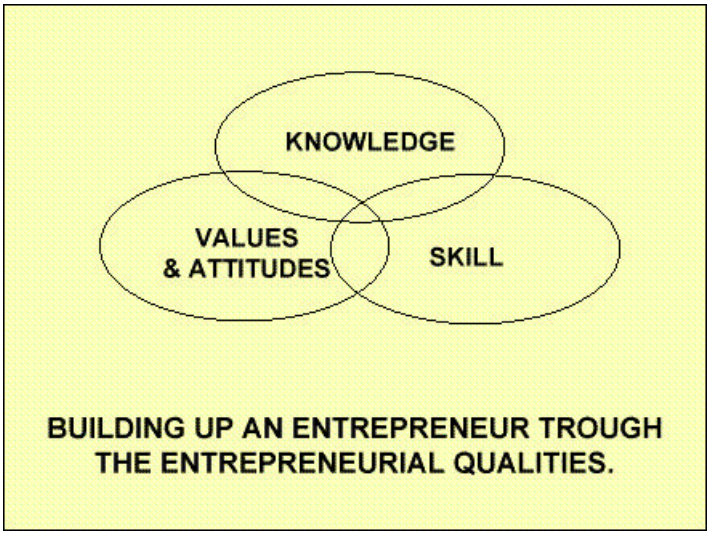

Figure 1. Qualities that make an Entrepreneur

Similarly, Cotton (1990, page 89), presents a scheme (Figure 2) illustrating the ingredients for a successful enterprise:

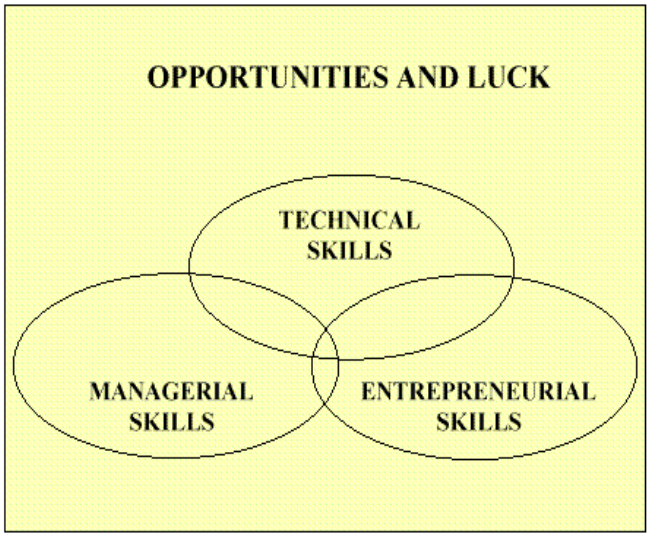

Figure 2.

The various skills listed by Cotton (1990) are in general the same as those presented by Lenko (1995). The Opportunity/Luck aspect slots into the set of qualities related to attitudes and values.

The Entrepreneurship / Enterprise Training Program at the Itajubá Federal Engineering College is run under partnerships with the PRODENGE/REENGE Program; the Euvaldo Lodi Institute - FIEMG; and the EFEI JÚNIOR corporate development program in Itajubá, fostering the entrepreneurial spirit among EFEI students.

As a consequence of the initial results of this project, the Itajubá Entrepreneurial Training and Business Management Center - GEFEI was set up as part of the Entrepreneurship / Enterprise Training Program run by the EFEI, forming an integral part of the strategy for the Itajubá Technopolis Project. Its main philosophy is to develop three separate groups of skills: Technical, Managerial and Entrepreneurial. In addition to professionals with excellent technical qualifications, today's market demands skills in these other two blocks as well.

An important aspect of the Center is its manner of operation. It does not operate outside the other activities of the institution, but rather uses Entrepreneurship / Enterprise Education techniques to teach engineering. Any discipline in its courses offers ways of developing the characteristics and attributes of an entrepreneurial profile in students, particularly Vision, Need for Achievement, Past Experiences, Self-Determination, Calculated Risk, Independence, Leadership, Innovation, etc.

The main objective of its teaching is thus to develop the ability to **learn how to learn** in its students. The GEFEI Center has been working with the following actions (Figure 3):

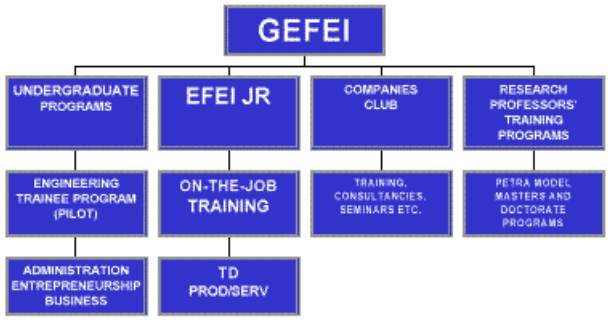

Figure 3

1- Current Situation:

At the moment, this Center is working in the following areas:

a) Graduate programs:

On-the-Job Training in Micro and Small Companies

Launched in March 1996 by EFEI JÚNIOR, this Program places on-the-job trainees with high technical qualifications at low costs in micro / small companies, for direct application of the knowledge acquired by the trainee during the graduate course, guided by two lecturers, one technical and other managerial. The main target of the trainee is to introduce improvements in areas where the company falls short, presenting a report to the company at the end of the training period listing the various activities carried out under this engineering training program. The final graduation report offers a managerial diagnosis and an action plan for the short, medium and long term for the company at which this on-the-job training took place.

Support for this diagnosis is acquired through the participation of the trainee in workshops in the areas of Entrepreneurship, Marketing, Human Resources, Financial Accounting, Quality, Production and Fabrication, all at the EFEI.

The third group is currently underway, with a total of 25 companies participating in the project.

Diploma Report (Product/Service)

Launched in April 1997, the principal objective of this activity is to encourage EFEI lecturers and students to develop products or services based on their final graduation report, slanted towards the market. At the end of the program the participant should have a business plan to hand, analyzing the various aspects that could ensure the feasibility of setting up a company.

b) Junior Company:

Set up by the GEFEI in 1996 with the main objective as supplying services by students to micro, small and medium-size enterprises in the region, including on-the-job training and small-scale projects. Ample leverage for these actions brought the EFEI and these companies closer together, showing them that this could well offer future career options for students as either employees or entrepreneurs. As a result, the EFEI Junior Program was

voted Junior Company of the Year 1996 and 1997 for Minas Gerais State.

2- Forthcoming Actions

In addition to the activities described above, others are also being implemented as follows:

a) Graduate Programs

Engineering Trainee Program: Project-Based Engineering Course

Working in partnership with PETROBRÁS and other companies, efforts are underway to adapt the successful experiment undertaken by the Production Engineering Department of Cambridge University. Initially, the final half-year of the Electrical and Mechanical Engineering Course at EFEI was set aside. Instead of the traditional supervised on-the-job training, students join an intensive 24-week program based on projects, and directly linked to companies in a wide variety of sizes and activities. As this is a pilot program it involves:

- 10 students;
- 20 corporate projects (lasting 15 - 30 days for each project, 4 projects for each student, always working in pairs);
- 15 technical visits;
- 10 final graduation projects;
- 04 management courses.

The following requirements are planned for this activity:

1. Sponsor companies supply projects and technical visits, partners for the management courses and offering food, housing, insurance, transportation allowances etc.
2. 15 companies covering all production sector areas.
3. Partnerships under an agreement with the British Council to set up an academic link between Cambridge University Engineering Department and the Itajubá Federal Engineering College.

b) Extension

Company Club

Activity that grew up from the on-the-job training program at small and medium companies where participant companies drew closer to the EFEI and called for new services such as: a) Training; b) Consulting; c) Seminars and others.

c) Teaching/Research/Extension

In addition to graduation reports focused on the management area of the company, which will continue under the existing program, some Master's degree research projects are slanted towards application in small and medium sized companies in the region, while others are more generic, looking more towards the Entrepreneurship / Enterprise Education field as a whole.

The results achieved so far may be considered as significant with regard to the professional training of students at EFEI, particularly more formal aspects of the development of skills and competencies considered essential for Engineering professionals. It is believed that future results for upgrading engineering education in Brazil will basically depend on sweeping changes in academic thinking, and particularly in terms of closer partnerships between the university and corporate worlds. Technological disciplines based on continuous innovation should tailor their objectives towards developing a profile that is both managerial and entrepreneurial for its students.

Network Formatting and Experiment Model

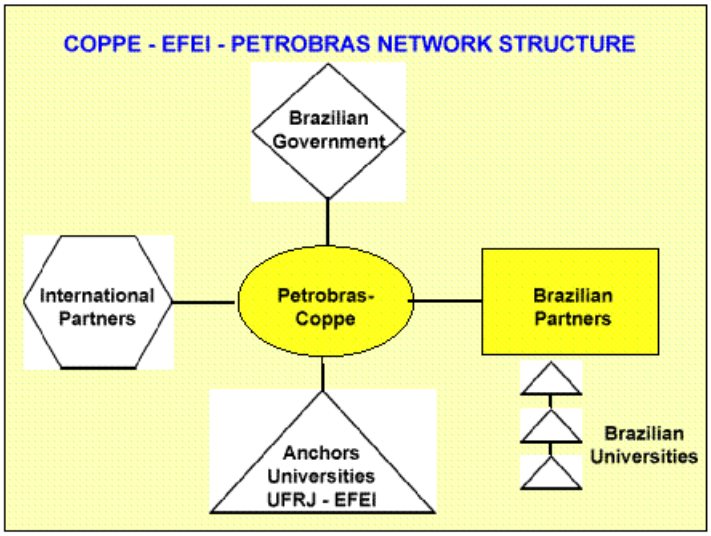

Figure 4

Experiment Model

Listed below are the development phases for this experiment:

Phase 1

Selection of students for the experiment.

Phase 2

Structuring projects slanted towards four different aspects of the PETROBRÁS production chain:

- engineering education projects based on research and development activities in the exploration, production, and supply areas;
- engineering education projects in construction and assembly projects of PETROBRÁS both upstream and downstream;
- engineering education projects for operational and logistics activities of PETROBRÁS, both upstream and downstream;
- engineering education projects in the investment planning and analysis areas.

Phase 3

Entrepreneurial and academic assessments of experiments and results.

Phase 4

Development of experiments through international partnerships and applications, in the operating areas of PETROBRÁS and its partners.

Phase 5

Extension of the network of the Excellence in Engineering Education Center to include other Brazilian universities in this experiment.

Phase 6

Application of this engineering education experimental model to theme areas under development at Coppe/UFRJ not directly linked to the oil industry and connected to scientific-base technology-intensive economic sectors.

Phase 7

Dissemination of this experiment model to other Brazilian and international companies.